Satellite User Requirements Survey

Periodically the ILRS Central Bureau surveys the community of SLR data users to determine (1) the level of interest in each of the satellites on the Priority List, (2) what analysis work is being done with the data, and (3) whether we are being responsive to the user needs. The most recent survey was taken in March-April 2001. We want to make sure that the data we acquire is being used and that we are responding to the requirements of our community.

The ILRS Analysis Centers and Associate Analysis Centers were asked to respond to the questions in Table 1. Seventeen SLR and three LLR centers responded (see Table 2). Satellite applications (see Table 3) included EOP, reference frame, gravity field, station position and motion, relativity tests, precision orbit determination (POD), quality control (Q/C) for stations, spacecraft modeling, and technique intercomparisons. Lunar applications included EOP, relativity, lunar gravity field, lunar ephemeris, tidal accelerations, and other lunar science. Synopses of the center responses are included in Appendix 1.

Survey Results

The data from each of the satellites currently being tracked by the ILRS stations is being used by at least three centers (see Table 4). Most of the satellites are being used by six or more centers, and many of the centers expect to use the data from the new LEO satellites such as Jason and Envisat as soon as it is available.

In general the users want more data, but the biggest issues appear to be with the high satellites and with the weekend and holiday outages on LEO satellites. Data coverage is improving in the Southern Hemisphere, but it is still weak. Tahiti and Arequipa are still disappointing.

Data accuracy from the well performing stations is adequate, but there are still too many weak, unstable stations. Perhaps the ILRS should issue a screened data set.

Data products should be more standardized and satellites should be better characterized. We need to implement more effective tracking strategies to be more effective. Improvements in stations documentation and eccentricities are underway.

Table 1. ILRS 2001 Satellite Requirements Questionnaire

1. **What applications of SLR data are underway at your center?**

2. **Which satellites are you currently using in your analysis work?**

3. **What are the applications for each satellite (station position/motion, gravity field, EOP, POD (specific missions), etc?**

4. **Are you receiving sufficient data volume?**

5. **Are you receiving sufficient data coverage?**

6. **Are the data of sufficient accuracy for your applications?**

7. **What other satellites do you plan to use in the future?**

8. **What do you need that you are not getting?**

9. **What other comments or suggestions do you have regarding the ILRS data?**

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Table 2. Centers that Responded to the Questionnaire

SLR Analysis Centers:

CSR (USA)	DUT/DEOS(Netherlands)
MCC (Russia)	

SLR Associate Analysis Centers:

AA (Russia)	Raytheon (USA)	NDE (Norway)
NERC (UK)	ESA/ESOC (Europe)	BKG (Germany)
AIUB (Switzerland)	DGFI (Germany)	INASAN (Russia)
AUSLIG (Australia)	GSFC/Lemoine (USA)	GSFC/Pavlis (USA)
Newcastle University (GB)		GFZ (Germany)

LLR Analysis Centers:

JPL (USA)	IAPG (Germany)	Utexas (USA)

Table 3. Areas of Investigation

Earth Orientation Parameters (EOP)

Reference Frame (Gm, center of mass, etc.)

Gravity Field (static and time varying)

Comparison with other techniques

Orbit development

Combination/Intercomparison

Station position/motion

POD (mission specific)

Q/C of stations

Spacecraft models

Gravitational physics tests

Lunar science

EOP

Gravitational physics tests

Tidal accelerations

Relativity

Lunar gravity field

Station position/motion

Lunar ephemeris

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Table 4. ILRS Satellite Questionnaire 2001 on Satellite Requirements

Satellite	Number of Users
CHAMP	4
GFO-1	4
ERS-2	9
TOPEX/Poseidon	8
Starlette	8
Westpac	5
Stella	8
Be-C	3
Ajisai	6
LAGEOS	14
GLONASS	6
GPS	7
Etalon	6
LLR Arrays	3

Table 5. Questionnaire Responses

Data Volume:

Not enough LAGEOS data
Weekend and holiday coverage a problem on TOPEX, CHAMP and ERS-2
Data too sparse on CHAMP for verification
Insufficient data on GPS, GLONASS, and Etalon for independent orbits and parameter estimation
Not enough data on low satellites in general

Data Coverage:

Coverage weak in Southern Hemisphere
Need better performance from Arequipa and Tahiti

Data Accuracy:

Too many stations exceed the 2-cm stability criteria; tighten criteria to 1 cm.
Too many weak stations
Too many stations with unstable biases; too much variation in the data
Still room for improvement in calibration and data screening
Should produce screened NP data sets; perhaps standardized screening package
Avoid collecting marginal data

Data is getting better from "good stations"
Data accuracy is sufficient

Table 5 (cont.) Questionnaire Responses

Suggestions and Comments

More standardized products (EOP, station position/motion, orbits, etc.)
Better characterization of satellites
Stella and Westpac are sunsynchronous; do we need Westpac for gravity field?
Speed up EOP results
Better long term predictions on LAGEOS and Etalon
A complete data set should be available right away; avoid archival differences
Does it make sense to try to track all of the satellites on the current list?
Station descriptions and eccentricities should be well-documented
Provide a file of ocean loading parameters in the ILRS format for all stations
Consider some other strategies for improving tracking effectiveness (MCC)

Lunar Comments

More data; improved new and full moon coverage; more Lunakhod 2 coverage
More lunar stations with better latitude coverage
More lunar reflectors
Data accuracy is fine

Other Comments

Data quality and speed of delivery greatly improved over the last year
Keep up the good work; continue improving the network
You are doing a great job
Appreciate the improved accuracy over the past few years

Appendix 1. SLR Analysis Survey Results

Organization	Respondent	Present Satellites	Future Satellites	Areas of Investigation
Analysis Centers				
CSR	Minkang Cheng John Ries Richard Eanes	ERS-2 Topex/Poseidon LAGEOS Stellette Stella Ajisai GPS Etalon CHAMP Westpac BE-C	JASON Envisat ICESat GRACE	POD (ERS-2,T/P) Reference frame (geocenter) EOP GM (scale) static/time varying gravity field QC station position/motion
MCC	Vladimir Glotov	LAGEOS GLONASS ERS-2 CHAMP Westpac Stellette Stella Ajisai	most new satellites	POD (altimetry) EOP station position/velocity navigation Q/C spacecraft models
DUT/DEOS	Remko Sharroo Ron Noomen	ERS-2 LAGEOS Westpac GFO Topex/Poseidon	Envisat JASON	POD (ERS-2,GFO, T/P) gravity field station position/motion EOP QC model development

Table 2 (cont.) SLR Analysis Survey Results

Organization	Respondent	Present Satellites	Future Satellites	Areas of Investigation
Associate Analysis Centers				
IAA	Zinovy Malkin	LAGEOS Etalon GPS GLONASS		EOP station position/motion POD reference frame
Raytheon - TRSS	Peter Dunn	Topex/Poseidon LAGEOS Starlette Stella Ajisai Westpac BE-C Etalon		POD (Topex, GFO) station position/motion gravity field EOP
Norwegian Div. For Electronics	Per Helge Andersen	LAGEOS	Etalon	reference frame EOP
NERC	Graham Appleby	LAGEOS Etalon GLONASS GPS Starlette Stella Ajisai Topex/Poseidon ERS-2	Envisat JASON	station position/motion EOP POD (altimetery) SLR comparison with radio orbits QC satellite signatures and modeling
ESA/ESOC	John Dow	ERS-2	ENVISAT TOPEX/Poseidon JASON CHAMP Cryosat	POD (ERS-2)

Table 2 (cont.) SLR Analysis Survey Results

Organization	Respondent	Present Satellites	Future Satellites	Areas of Investigation
Associate Analysis Centers (continued)				
BKG	Bernd Richter Maria Mareyen	LAGEOS AJISAI Stella Starlette GPS	GRACE CHAMP	EOP station position/motion POD (altimetry) gravity field GM
AIUB	Urs Hugentobler	GPS GLONASS	CHAMP GRACE JASON GOCE	POD
DGFI	Detlef Angermann	LAGEOS	Starlette Stella Ajisai Etalon	station position/motion EOP geocenter reference frame gravity field
INASAN	Suriya Tatevian	LAGEOS	Etalon	EOP station position/motion gravity field POD (altimetry)
AUSLIG	Ramesh Govind	LAGEOS Stella Strarlette GLONASS	GRACE CHAMP	station position/motion EOP orbit analysis gravity field POD (altimetry)
GSFC	Frank Lemoine	GFO-1 Topex/Poseidon ERS-2	JASON Envisat	POD (altimetry) EOP station position/motion gravity field

Table 2 (cont.) SLR Analysis Survey Results

Organization	Respondent	Present Satellites	Future Satellites	Areas of Investigation
Associate Analysis Centers (continued)				
GSFC	Erricos Pavlis	LAGEOS Etalon GPS Topex/Poseidon CHAMP Starlette Stella Ajisai Westpac	GRACE JASON GOCE ICESat	EOP station position/motion POD and modeling reference frame/Gm and geocenter combination and intercomparison gravitational physics tests
Shanghai Astronomical Obs.	Yang Fumin	LAGEOS Topex/Poseidon ERS-2 Starlette Stella Etalon	GPS Westpac CHAMP	EOP station position/velocity POD for altimetry
Newcastle University	Phil Moore	Topex/Poseidon ERS-2 GFO Lageos	Envisat JASON	POD (ERS-2, GFO) gravity field altimetry
GFZ	Rolf Koenig	all retroreflector satellites	GRACE	gravity field POD (CHAMP) GPS calibration

Table 2 (cont.) SLR Analysis Survey Results

Organization	Respondent	Present Satellites	Future Satellites	Areas of Investigation
JPL/LLR	Jim Williams Jean Dickey	LLR arrays		EOP lunar science relativity gravitational physics tests tidal acceleration lunar ephemeris
IAPG/FESG	Jurgen Mueller	LLR arrays		lunar orbit and rotation lunar gravity field station coordinates/motion relativity
UTexas	Judit Ries	LLR arrays		EOP